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Scott W. Kelley, Reg. No. 30,762 — August 2, 2005 Date

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of	Group Art Unit: 2876
Mark M. Kotik, et al.	Examiner: Nguyen, Kimberly D.
Serial No. 10/712,935	
Filed: November 12, 2003	Docket No. PREDYN-44227
For: IDENTIFICATION BAND WITH ADHESIVELY ATTACHED COUPLING ELEMENTS	

DECLARATION OF Walter W. Mosher, Jr.
UNDER 37 CFR 1.131

WALTER W. MOSHER, JR., hereby declares as follows:

1. I am one of the joint inventors of the subject matter of the above-identified U.S. Patent Application Serial No. 10/712,935, filed November 12, 2003.

2. I am President of Precision Dynamics Corporation (hereinafter referred to as PreDyn). PreDyn is the assignee of the above-identified application. My co-inventor joined PreDyn in 2002.

3. I have worked in the field of identification devices for more than 20 years and RFID technology for over 10 years. For example, I am one of the joint inventors of Charles, et al., U.S. Patent No. 4,318,234 (issued March 9, 1982, filed January 10, 1977), which relates to an identification device with versatile imprinting means. I am also the sole inventor of Mosher, Jr., U.S.

Patent No. 5,937,600 (issued October 26, 1999, filed September 9, 1998), which relates to a laminated radio frequency identification device. I am also a joint or sole inventor of the numerous other U.S. Patents relating to RFID identification devices.

4. As co-founder and head of RFID development for PreDyn, I conceived of the subject matter of the present application prior to November 13, 2001, the date the De La Huerga application, U.S. Publication No. US2002/0084904 was filed with the United States Patent and Trademark Office. In this effort, several employees, consultants and intellectual property legal counsel worked under my guidance in developing my conceptual innovations, in an ongoing and continuing development program, produced several reports, proof-of-concept demonstrations and practical prototypes of proposed RFID-utilizing products and systems. In the present case, we diligently worked at reducing the subject matter of the present application to practice, crystallized by my co-inventor and myself, up to and beyond our filing date of November 12, 2003.

5. My review of correspondence, purchase receipts, drawings, and other materials documenting our conception and reduction to practice of the identification band with adhesively attached coupling elements invention indicates, and documents confirm, that this conception occurred well prior to the filing date of the De La Huerga application. See Exhibits A, B, C, D and E, attached hereto.

6. As shown in Exhibit A, we conceived of the identification band with adhesively attached coupling elements set forth in the specification and claims of application, Serial No. 10/712,935, at least as early as early 1996. As shown in summary on page 2 of Exhibit A, an area for discussion was fastening methods and apparatus for wristbands. On page 7 of Exhibit A, we discuss two variations on the closure of a wristband activating an RFID tag. Under Group II, we discuss including an RFID tag and variations on inductive and capacitive coupling in the closure device. Further, under Group III, we specifically discuss how the closure of the wristband can activate RFID operation. We also discuss modifying existing patents where an adhesive or mechanical closure is augmented with conductive components to enable or activate an RFID tag when closed and disable operation if opened. (Exhibit A, pages 2 and 7). We spent the subsequent time period designing devices and manufacturing specifications, and continued development of the concept through November 2003 when the present application was filed.

7. As shown in Exhibit B, in May 1997, we worked on reducing to practice the inventive concept first conceived in November 1996. On page 2 of Exhibit B, we summarize designs including RFID tags in closure mechanisms for various products. On pages 6 and 7 of Exhibit B, we go into greater detail regarding designs involving the Soft Guard, the Clincher, the "touch memory" carrier, and the "pocket" wristband model - discussing physical configurations for the tags and closure mechanisms.

8. As shown in Exhibit C, a report entitled "Product Capability Demonstration: Precision dynamics RFID Wristband Systems," in October 1997 we worked on developing a number of proof-of-concept demonstrations. Notable to the instant application, on pages 3 & 4 of Exhibit C we cite the "Security" concerns that were earlier (and later) embodied in discussions of RFID-closure methods; further, on page 5 of Exhibit C, we specifically note the use of an RFID inlet in the "Softguard clasp" and the "Clincher fastener." "Clincher," it should be noted, is the company's trademarked brand name for security-directed bands and related products whose target goal is tamper-evident and/or tamper-proof subject identification, a key embodiment of the instant application.

9. As shown in Exhibit D, in August 1998, we continued working on the inventive concept. We discussed how reactively coupled circuit elements between different laminae can be used to achieve the inventive purpose. (Exhibit D, page 2). This is shown again on page 4 of Exhibit D where we discuss the activation of a tag by attaching or removing conductive tape. We also discussed power control circuitry in the tag to activate different system elements as needed. (Exhibit D, page 4).

10. As shown in Exhibit E, in August 1999, work on the inventive concept continued as we began working on a disclosure related to the inventive concept, tentatively titled CIRCUIT MAKING CLOSURE FOR RADIO FREQUENCY IDENTIFICATION DEVICE WRISTBAND. (Exhibit E,

page 2).

11. Further, as shown in Exhibit F, in October 1999, our reduction to practice continued as we were designing electronic circuits to achieve the inventive concept. The circuit including a diode as shown was contemplated as achieving a fast switch device without designing new materials. (Exhibit F)

12. It should be clear from the attached exhibits that the cited subject matter of De La Huerga was well-known to the inventors of the instant application, as we had conceived of and been developing this subject matter well prior to the De La Huerga filing date.

I further declare that: all statements made herein of my own knowledge are true and all statements made on information and belief are believed to be true; and these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such false statements may jeopardize the validity of the application or any patent resulting therefrom.

Date: July 31, 2005

Walter W. Mosher, Jr.

Attachments
Exhibit A - November 1, 1996 Memo (8 pages)
Exhibit B - May 1997 Memo (7 pages)
Exhibit C - October 28, 1997 Report (7 pages)
Exhibit D - August 12, 1998 Memo (13 pages)
Exhibit E - August 16, 1999 Report (8 pages)
Exhibit F - October 6, 1999 Report and Notes (2 pages)

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FAX MESSAGE

DATE: November 1, 1996
TO: Precision Dynamics Corporation
ATTN: Mr. Ozzie Penuela
FAX #: 818-899-4045 5592
FROM: Mike Beigel
BTC CORR#: PD961101
SUBJECT: RFID PROJECT
CC: Dr. Walter Mosher

Dear Ozzie, Walter:

I am enclosing the first version of the document which will eventually contain all the disclosure material for the RFID project.

Since it is easy to modify the format of the document in this early stage, please give me your opinions on the general organization.

The "invention" ideas are in the section starting on page 5. I have some additional material on the ideas (some hand drawings and additional handwritten notes) which are not included.

The most important thing is to review the invention ideas and decide where to focus our further efforts.

Sincerely,

Mike Beigel

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9 pages total

EXHIBIT A

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RFID Technology in Identification Wristbands and Flexible Labels

This document will summarize RFID technology and its application in products and systems involving ID wristbands, flexible labels and associated product types.

This document will include invention material and enabling technology description to generate patent applications, product designs and system designs.

Numbered revisions to this document will form the summary of project activities by BTC with respect to Precision Dynamics RFID intellectual property and product development studies.

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Prepared for: **Precision Dynamics Corporation**

Prepared by: **Michael Beigel,**
Beigel Technology Corporation

Draft #: 02

Date: November 1, 1996

Distribution: Walter Mosher
Tom Mahoney
Ozzie Penucla: PD Internal list

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SUMMARY OF TOPICS

1. Wristband design and manufacturing

Summary of Precision Dynamics manufacturing technology, wristband product designs, production methods and equipment.

Materials

Fastening Methods and Apparatus

2. RFID Technology Summary

Survey of current RFID technology as applicable to Precision Dynamics product development.

RFID Communication Technology

Passive and Active Transponder Types

Tag Programming Methods

Frequency Ranges

3. RFID applied to wristbands and flexible labels

Specific product development plans to facilitate early market entry and technology leadership.

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Wristband Design

Printed antenna w chip

Printed antenna and electronics

Methods of programming

Design for production economy

Materials

Manufacturing Process

4. Reader systems

RFID reader systems compatible with PD RFID wristband and flexible label products.

Fixed stations

Portable stations

RF-DC Communications

5. Database manager systems

Database manager systems compatible with RFID technology and customer database applications.

Data collection

Communications Manager

RF Data Communication

Cellular Communications

6. Product and Technology Ideas

Ideas for patent applications in areas of RFID technology, ID wristbands and flexible labels

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7. Enabling Technology Documents

Documents which provide descriptions for implementation of ideas, materials, methods or processes disclosed in Product and Technology ideas. These documents will be used to provide enabling disclosure verification in patent applications.

8. Example Embodiments

Product or system designs proposed for development, production and marketing.

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6. PRODUCT AND TECHNOLOGY IDEAS,

RAW FORM, GROUPED BY TYPE

These product and technology ideas may or may not be patentable, realizable with current technology, or appropriate for product designs. The ideas are primarily to stimulate further discussion, research and evaluation for directing serious efforts towards technology, intellectual property and product development.

GROUP I: Flexible Disposable RFID Tag for Wristband

1.Laminated Lumped Transponder Antenna on flexible substrate, and Manufacturing process

Inductive and capacitive elements of antenna structures for RFID transmissions are printed or stamped on one or both sides of one or more layers of flexible material in the manufacturing process for a wristband or flexible label. Continuous flow processing of (plastic) sheet material on automatic machine results in complete antenna structure contained in flexible end product. Embodiments for various frequency ranges from 100 KHz to 3 GHz are disclosed.

RF antenna on flexible substrate, multi-layer capacitive and inductive coupling

Structures or patterns of conductive material printed on flexible sheets of insulating dielectric material form inductors and/or capacitors. Inductive and/or capacitive coupling between structures on different layers of material form a resonant multi-element antenna circuit without any electrical (ohmic) connection between the elements on the different layers. Possible capacitive coupling to (silicon) IC chip structure affixed to one of the layers of sheet material form a complete ID tag wristband or flexible RFID label.

RFID tag on polymer substrate, with passive components only

An RFID tag made with passive elements (inductors, capacitors, resistors, electrical contacts) is imprinted on one or more layers of flexible material. Possible embodiments are multiple resonant circuits or delay lines. Programming of information on the tag is performed by opening or closing circuits on the tag according to a programming method, resulting in unique coding of each tag up to the number of combinations of open or closed circuits.

RFID tag characterized by programmable multiple delay lines

A high-frequency RFID tag is characterized by a plurality of delay lines, each of which can be switched in or out of the circuit by a programming method. In response to an electromagnetic impulse radiated to the tag by a reader, the tag outputs a sequence of reflected pulses based on the number and length of delay lines connected to a reflective antenna or antennas on the tag, the sequence of pulses determined by the programming of the delay lines.

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7. RFID tag characterized by spectral response to an interrogating signal

An RFID tag characterized by a unique spectral response to an interrogating signal. The tag is programmable to produce a unique set of frequency components in response to the interrogating signal. The interrogating signal can be an impulse, a swept frequency, a waveform having multiple frequency components or a series of stepped frequencies. The tag can be either active (battery powered), passive with active components (in which operating power is derived from the signal coming from the reader and active circuitry is employed in the tag), or purely passive (in which passive resonant circuits or delay lines are used).

Attachment of Integrated circuit ID tag to flexible substrate antenna

An integrated circuit RFID tag is attached to a flexible antenna in a continuous manufacturing process. The attachment may be by capacitive, inductive or ohmic coupling. Means for placing and securing the IC onto the flexible substrate may include ultrasonic bonding, conductive adhesive, UV curing adhesive, or laser welding. Production process and machinery are disclosed.

RFID and Printed Information on flexible ID tag

An RFID tag code as well as printed information are programmed onto a flexible tag. The printed information may be readable text, bar code, photographic print or other. The RFID tag may be programmed at the factory or at the time of deployment. Information contained in the RFID tag may be read by an RFID reader at the time of printing the printed information and used in formulating the information to be printed.

RFID data programmed by printing with conductive ink on a contact matrix

RFID data are programmed onto a flexible RFID tag by printing a pattern of conductive ink marks onto a contact matrix electrically connected to multiple terminals of an RFID tag. The RFID circuit may be either an IC chip, polymer semiconductor structure, or printed passive structure. The printed pattern may be applied either at the factory or at the place of deployment. Additional printed information may be put on the tag at the same time (bar code, readable characters, photographic information, etc.). A device for printing the information on the tag in manufacturing or deployment environment is disclosed.

RFID tag made with polymer semiconductors on a flexible substrate

A complete RFID tag using polymer based active circuitry is deposited onto one or more layers of flexible material. The tag includes energy receiving element (antenna); information transmitting element (antenna); and active circuitry for deriving operating power (and possibly clock signal) from the energy receiving element, reading an ID code programmed into the circuit, and outputting the ID information to the information transmitting antenna. Enabling disclosure for polymer semiconductors, and fabrication method must be obtained.

Flexible RFID Tag with electromagnetic energy absorbtion means and optical information transmission means (LED)

The tag is energized by an electromagnetic field signal. The information programmed in the tag is transmitted optically by a polymer LED.

Flexible ID tag with visual readout activated by external electromaguitic field signal

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An electromagnetic signal provides power and enabling information to a flexible tag with an LCD readout. Upon energizing and validation signal, the (wristband) displays optically readable output according to information programmed in the tag or received from the interrogating/enabling device.

GROUP II: Disposable Wristband, Re-usable RFID Tag

Disposable wristband and re-usable RFID transponder (Pemuela patent 5,493,805)

In place of a button memory in Pemuela 5,493,805, an RFID tag is included. Since the RFID tag does not require physical or electronic contact to transfer information, additional embodiments appropriate to secure, sterile containment of the RFID tag should be disclosed. Different types and shapes of RFID tag should be disclosed. Capacitive or inductive coupling to an antenna fabricated on the disposable wristband should be disclosed.

Extension of Soft-Guard Patent

Closure device for Soft Guard wristband augmented to include an RFID tag. Capacitively or inductively coupled antenna installed or printed on inside of wristband tube.

GROUP III: Closure of Wristband Activates RFID Tag

Wristband RFID antenna activated by closure of wristband

Operation of RFID tag in flexible wristband is enabled by closure of wristband, as security feature. Enabling may be accomplished by: connecting an antenna, providing power to RFID tag, tuning an antenna, changing the state of a logic input to the tag logic. Enabled tag verifiable by: operation or non-operation, changed code based on logic input.

18. Conductive adhesive wristband closure activates RFID tag (Mosher patent 5,457,906)

Adhesive closure of wristband is augmented by using conductive adhesive to close an electrical circuit, thereby activating RFID function.

Closure mechanism (Peterson patent 5,479,797) activates RFID wristband

The closure mechanism of Peterson's patent is augmented to enable or activate an RFID tag wristband when closed, and to disable operation if attempted to open. Wristband may contain integral antenna and/or RFID tag disposable or replaceable. Inside of closure mechanism may be coated with conductive material to complete an electrical circuit when engaged.

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GROUP IV: Adjustable Wristband Antenna, Constant Resonant Frequency

Adjustable RFID wristband antenna with constant resonant frequency

When a wristband RFID tag is adjusted to fit different sizes, the integral antenna maintains a constant resonant frequency, for optimum energy and information transfer. Enabling means must still be discovered.

GROUP V: Programming RFID Tag, Systems & Database Management

Programming RFID wristband at IC fab, wristband factory, end user location

An RFID tag may be programmed with several types of unique or generic information. Depending on the technology used to implement the tag, programming at the IC fab, wristband factory, end user location, or combination of these may be appropriate.

Identification and database management using wristband, RFID, RFDC

The information contained in an RFID tag is integrated into a complete database management system appropriate to the requirements for managing the identified population. The RFID tag may contain permanent information programmed at the factory not alterable by any means, permanent information programmed at the application site, and alterable information

Patient ID system and database manager for hospitals, using RFID

GROUP VI: Reader Antenna Systems

Doorway RFID Reader Antenna

Reader antenna for low or mid frequency RFID system is disposed on both sides of a doorway. No conductors are disposed along the floor. The configuration on both sides of the doorway creates a more complex E-M field pattern, enhancing reading percentage. A connector or connectors through the wall between the coils provides electrical connection of the E-M structure.

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WALT.

EVALUATION OF RFID TECHNOLOGY FOR PRECISION DYNAMICS PRODUCTS

Phase 2A:

Product Concept Development for immediate introduction

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Prepared for: Precision Dynamics Corporation
By: Michael L. Beigel
Date: May 12, 1997
May 23, 1997
May 27, 1997

SUMMARY

This document presents wristband RFID product design concepts based on immediately available RFID products.

EXHIBIT B

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Change in Project Objectives

To facilitate immediate market entry, we are now considering suppliers of RFID tags and readers with immediate availability, even though system specifications are not optimally met. Our objective is to have a product and system to show to the marketplace by the end of May.

Compromises for Immediate Products

The products from our industry search which are available for immediate introduction do not meet the original combined objectives for cost, reading distance and form factor. Therefore some of these objectives must be sacrificed in order to introduce a product.

My suggestion for the best approach to the product design would be to concentrate on providing the most useful product functionality.

Historically, electronic products which provide the functionality to serve a large market potential eventually decrease in price to meet the economic demands of the growing marketplace. Examples: Pocket calculator, digital wristwatch, cell phone.

Product Concept Development

Based on a review of PD's present wristband products, we have suggested four product modifications involving the addition of RFID tags to present wristband designs:

RFID tag in closure mechanism for Soft Guard
RFID tag in closure mechanism for Clincher
RFID tag in modified version of "touch memory" carrier
RFID tag inserted in "pocket" wristband model

Along with the tags, we need readers and products to collect additional data besides the ID tag number, as well as systems to transmit the information to and from a central database, and database management software. Configurations of readers include:

Handheld portable read-only reader with data storage (RS232 or other COM interface) to main computer)

Handheld reader/writer/database storage and retrieval terminal (RS232, infra-red, or RF/DC interface to main computer)

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Fixed point reader with direct communication interface to main computer.

Wall mount
Portal
Floor mat

Evaluation of Potential Technology and Product Suppliers

We reviewed over 70 companies which are suppliers of RFID technology, for the general aims of the project.

We are considering 13 companies as potential suppliers for the IMMEDIATE product suppliers. We have had meetings with 4 suppliers and phone conferences with over 20 suppliers.

Surprisingly, only one supplier - TIRIS - appears to have a compatible line of read-only, read-write and portable database tags of various form factors, and associated readers available for immediate delivery.

Another supplier, EID/Trovan has read-only transponders with a better ratio of size-price-performance, but does not have a compatible line of read-write transponders.

Another supplier, Sokymat, has a broad line of transponders with read-only and read-write capabilities, but no source (as of this date) for appropriate readers.

SHORT TERM PRODUCT INTRODUCTION:

Precision Dynamics wants to introduce RFID based wristband products immediately.

It is not known what the market really wants, or what quantity of tags will actually be sold.

Since the RFID company survey we sent to prospective suppliers has indicated 10 million quantities of tags, we cannot expect to get pricing comparable to our goals for small (and indeterminate) quantities

The easiest tags to get at the present time are read-only and read-write passive tags with a few inches reading range, operating at 125 KHz, and possibly at 13.5 MHz.

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TIRIS tags operate at 134.2 KHz and have a better reading range than other low frequency tags, at the expense of much increased tag cost and bigger form factor.

The tags that operate at 2.4 GHz and 900 MHz are all susceptible to de-tuning and "shading" by the proximity of the human body.

Tags at intermediate frequencies between 13.5 MHz and 900 MHz do not seem to be readily available.

COMPANIES IN CONSIDERATION FOR NEAR TERM SUPPLIERS

Texas Instruments (TIRIS), Productivity Enhancement Products, Snyder Electronics

Texas Instruments (TIRIS) has the most comprehensive product line that is known to be reliable and readily available. The TIRIS tags come in read-only, read-write and multi-page read-write versions, in a reasonable variety of sizes and shapes. TIRIS makes fixed point reader systems with the greatest operating range of reader-tag distance.

Productivity Enhancement Products (PEP) makes high quality portable scanners for the TIRIS tags, including a self-contained keypad datalogger based on a Symbol Technology handheld unit.

The main drawback of the TIRIS tags is their size and price. The tags are larger and approximately twice as expensive as alternative units. Another drawback is TI's inflexibility with respect to customization of products in small to medium quantities.

For introductory product line features, however, the combination of best reading range and interchangeable compatible transponder functions (read-only, read-write, multipage read-write) would make TIRIS / PEP the easiest choice for implementation.

PROGRESSION TO MEDIUM-TERM PRODUCTS

TIRIS also plans to introduce a product line at 13.5 MHz with much lower cost, in the form of flexible labels. However, this will not be inherently compatible with their present product line. Multi-technology readers could probably be developed to read both types of tags.

AEG-Trovan, Electronic Identification Systems Inc.

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Trovan has the smallest glass capsule transponders with the best reading range in the FDX technology. Trovan also has hand-held readers and readers with keypads.

Trovan claims it is suing Sokymat for patent infringement in connection with technology for direct bonding the coil to the chip. The bonding of the coil to the chip is a major factor in determining the cost of the ID tag. There s also the question of the viability of Sokymat as a supply source if they lose the lawsuit and are unable to find non-infringing technology.

Trovan uses a phase-shift encoding technique for its systems, which is not second-sourced by other companies in the industry.

PROGRESSION TO MEDIUM TERM PRODUCTS

Trovan has indicated an interest in cooperatively developing a read/write system. We should find out what their business proposal is, and also whether the read-write system would be compatible with the present read-only system

Snyder Electronics

Snyder electronics was introduced to us by the TI sales representative as a potential supplier of custom reader/antenna systems compatible with TIRIS products.

Mr. Wayne Snyder came to PD and demonstrated a monitoring system for geriatric patients, comprised of a leg-band carrying a TIRIS 32 mm transponder, and a floor-mat antenna and reader system which appeared to reliably read the ID tag when a person traversed the floor mat.

There are numerous possibilities for business arrangement with Snyder Electronics, with PD being either the customer (floor mat readers) or the supplier (modified "legband" bracelets), and possibly manufacturing and supplying the tag modules.

Sokymat, ID Systems Ltd.

Sokymat presented a broad product line of very reasonably priced tags, however they do not make readers.

Sokymat recommended ID Systems Ltd., in England as a manufacturer of readers for their tags. However, ID systems does not yet make readers with acceptable reading distance specifications at this time. They expect to have acceptable product within a few months.

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This is disappointing since the Sokymat products were most attractive from a price/perfomance standpoint.

We will have to eliminate Sokymat/ID systems from consideration for immediate-term product, and place them among the companies under consideration for medium term implementation.

Motorola/Indala

Though Motorola/Indala appears to have a potentially viable product line for immediate use, they did not respond to our inquiry letter. I have placed another call to their RFID guy to see if we can get their attention.

WRISTBAND RFID PRODUCTS

RFID tag in closure mechanism for Soft Guard

1. Insert a 11-14 mm glass tag or tag assembly into a round hole drilled into a softguard closure.

2. Redesign closure in 2 halves with cavity, to accept larger rectangular tag module, and be sealed together by ultrasonic weld or cementing, for greater read distance and possible read-write function.

Rectangular tag module consisting of rectangular wafer of ferrite with copper coil wound around it, with IC chip cemented to ferrite, with copper wire bonded to gold pads on chip. Possible collaboration with Trovan or Sokymat for automatic production of the assemblies.

Rectangular module could also be used with other tag closure mechanisms, for instance Clincher or general purpose substitute for touch memory holder to go on most wristbands.

RECOMMENDATION: Trovan tag and reader for short term product.

RFID tag in closure mechanism for Clincher

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1. Modify closure mechanism of Clincher to accept a 32 mm TIRIS tag, so that the resulting tag can be read through portal or doormat antennas for use in security systems in which tag passes through portal.

2. Design re-usable RFID tag module for wristband to slip through.

RECOMMENDATION: TIRIS 32 mm tag, Snyder floor mat reader, TIRIS long-range reader, PEP keypad reader-logger.

RFID tag in modified version of "touch memory" carrier

Design modified version of touch memory carrier to contain coin shaped tag. Could also use ferrite block tag.

RECOMMENDATION: Sokymat 20 mm disk tag in re-designed thin profile band attachment.

RFID tag inserted in "pocket" wristband model

A thin, flexible RFID tag inserted in a pocket model wristband, possibly heat-stamped in place to prevent loss.

RECOMMENDATION: Best present products are the Sokymat tags.

DISPOSABLE VS.RE-USABLE TAGS

At the present time, no tags are available at a "disposable" price. We need to decide what is the maximum price for a disposable assembly. Under 50cents? It would seem at the present time there is no sense in making disposables. Most likely the 13.5 MHz tags promised by TIRIS and others will fill this gap in a few months.

DECISION MATRIX FOR IMMEDIATE TERM PRODUCTS

Starting with the original specification sheet for the Phase 1 project, and adding the decision criteria in Phase 2 A, we can simply compare the offerings of the few companies qualified for near term solutions to the matrix. We can use weighting factors to emphasize functional utility over disposability and cost factors. Quotations from companies as appendix.

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PRODUCT CAPABILITY DEMONSTRATION:

PRECISION DYNAMICS RFID WRISTBAND SYSTEMS

SUMMARY: A working demonstration of Precision Dynamics developmental RFID wristbands, reading/writing devices and sample software applications.

The Demonstration is a "portable" system which can be easily set up, displayed and tried by potential customers at trade shows, customer locations and at PD home office.

Michael Beigel
October 28, 1997
For Precision Dynamics Corp.

DRAFT 1: NOT FOR DISTRIBUTION

ALL PAGES CONFIDENTIAL

EXHIBIT C

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DEMO SOFTWARE APPLICATIONS:

Simplified examples of user application modes possible with the system.

Demo Application 1:

PRECISION WORLD THEME PARK

A theme park where people use RFID bracelets to access rides, buy food and merchandise, and for other functions. An RFID wristband on each customer serves as the sole device for transactions within the park, acting as a remote "smart" card.

Upon registration/admission the customer obtains authorization to spend a certain amount of money on anything within the park (rides, food, merchandise). Once inside the park, the customer accesses rides by walking through a gate which reads the tag and debits the customers account. When purchasing food or merchandise, the food or merchandise is priced at the register and the tag is scanned by a handheld or desktop reader.

The customer can access the information in his/her tag at kiosks which read the tag and display current status including entitlements used and cash remaining. The customer can "re-fill" the tag with cash similar to an ATM transaction.

The management information system keeps track of revenues (issued to and used by customers), statistical analysis of ride popularity and usage, merchandise sales and inventory, food sales and inventory.

Registration/Admission: Customer enters park and checks in with cash or credit card.

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Entitlement Purchase: Customer buys one or more wristband and chooses amount and type of entitlements.

Entitlement Usage: Customer can enter rides by simply walking through gate and getting "green light" upon real-time verification of valid entitlement. Customer can buy food and merchandise by having the articles and the wristband scanned by a portable hand-held scanner at purchase location.

List of costs for Rides, Food, Merchandise

Restriction categories for Rides

Security

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Demo Application 2:

PRECISION GENERAL HOSPITAL

The hospital system uses RFID wristbands and other RFID tags to track patients from admission through departure, security of visitors and employees, access control, treatment and materials, time and attendance, etc.

Three or more tag types are used: read only, read-write, multi-page read write. Some tags/wristbands are disposable, and some are re-usable with disposable wristbands.

In addition, long-range surveillance tags on certain wristbands protect high security risk individuals such as babies and Alzheimers patients.

Registration/Admission: Patient checks in. Enter insurance data, personal data, medical history, reason for check-in, etc. Issue wristband with R/O, R/W, MP capability.

Doctor visit: Doctor has wristband, patient has wristband. Enter procedure performed, medication prescribed, other data.

Nurse visit

Medication + Supplies

Room Charges

Patient Medical Database

Billing

Security

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GENERAL SYSTEM SPECIFICATIONS

WRISTBANDS:

Trovan in Softguard clasp
TIRIS (read only, read-write, multipage) in
    Softguard clasp
    Clincher fastener

Tag Types

Trovan Read-Only

TIRIS
    Read-Only
    Single Page Read-write
    Multi-page Read-write

READERS

Trovan Grip Computer
PEP/SYMBOL Portable Terminal
PEP Easyreader
TIRIS Fixed point reader
    Snyder floor mount antenna
    TIRIS doorway antenna
    TIRIS desktop antenna

Central Computer Demo Application

Initial screen
Real-time application screens
Report screens
Database screens

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Central Computer Interface

Real Time Read
- TIRIS Fixed Point
- PEP/TIRIS Handheld
- Trovan Handheld

Download of Handheld
- PEP/TIRIS Handheld
- Trovan Handheld

Write to tag (TIRIS only)
- From Central Computer
- From Handheld

Remote (Hand held) Terminals

PEP/SYMBOL
TROVAN GRIP
- Operating System
- Tag Interface Software
- Central Computer Interface Software
- Application Software
- Application screens and flow chart

Real Time Display: Central Computer

Read Tag
Display tag data
Display data associated with tag
Display transaction involved
Enter transaction
Update database
Update tag data

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Software Programs to generate Application

Windows 95
Low level device handlers
Handheld interface software
Microsoft Excel
Microsoft Access(?)
Visual Basic?

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DATE: August 12, 1998
TO: Tom Mahoney, Esq.
ATTN:
FAX #: 714-718-1122
FROM: Mike Beigel
BTC CORR#: TM980812-B
Cc: Walter Mosher 818-897-7871
Oswaldo Penuela
Walter Seemeyer
SUBJECT: Patent application review, Polymer patent strategy

CONFIDENTIAL MATERIAL, ALL PAGES

Dear Tom, Walter, Walter, Ozzie:

The folowing document is a review of all presently pending patent applications, plus strategy for completing patent applications and pursuing technology development in polymer semiconductor areas.

Please contact me with any questions or suggestions.

I will be away from my office from August 13 and returning August 18.

Sincerely,

Mike Beigel

14 pages total

EXHIBIT D

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RFID TECHNOLOGY PATENT APPLICATION REVIEW AND STRATEGY FOR PRECISION DYNAMICS CORPORATION

ALL PAGES CONFIDENTIAL MATERIAL

Prepared for: Precision Dynamics Corporation
By: Michael L. Beigel Beigel Technology Corp.
Date: August 12, 1998

SUMMARY:

1. Review of patent applications for possibly conflicting disclosure or claims
2. General review of claims in #5234 (Polymer RFID Tag) application
3. Presently completed additions to Polymer Semiconductor material (5331)
4. Suggestions for new Polymer Semiconductor disclosure to be developed (no #)
5. Patent search for issued US patents relating to polymer semiconductors
APPENDIX 1: Polymer semiconductor preliminary patent search results

SUMMARY OF APPLICATION STATUS

DOCKET	TITLE	PROV	PAT	PCT
5220	Identification Device Having Reusable Transponder	2	2	3
5221	Laminated Radio Frequency Identification Device	2	1	0
5222	Reactively Coupled Elements In Circuits On Flexible Substrate	2	2	3
5234	Polymer RFID Tag On Flexible Substrate	2	1	1
5331	Polymer Transponder with Modifiable Memory	0	0	0

0: No action yet
1: Preparing Application
2. Filed
3. Prosecution
4. Granted

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1. Review of patent applications for possibly conflicting disclosure or claims

Each patent application is annotated for disclosure that may relate to another patent application.

5220 REUSABLE TRANSPONDER

5222 Reactive Coupling
Page 8 (line 20) – page9 (line 3)
Explicitly mentions 5222 application, no conflicts

5221 LAMINATED RFID

Contains significant disclosure that relates to reactive coupling of circuit elements, between different laminae.

The material (Fig 11, 12, 13), Page 14 (line 16) – Page 17 (line 3) relating to Reactive Coupling should be claimed in some way not in conflict with #5222

5222 Reactive Coupling:
Page 6 (line 1-6)
Fig. 11, 12, 13
Page 14 (line 16) – Page 17 (line 3)

5234 Polymer RFID
Page 6 (line 1-6)

5222 REACTIVE COUPLING

Possibly ADD the section that is presently disclosed in LAMINATED RFID (Fig 11,12, 13 and text Page 14 (line 16) – Page 17 (line 3), and claim it in this patent application.

5234 POLYMER RFID TAG

5221 Laminated RFID
Figure 1, 2, 8(A, B, and C) 9, 10: depicts lamination production techniques
Page 14 (line 11) – Page 15 (line 14): describes a tri-laminate tag

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2. General review of claims in 5234 (Polymer RFID Tag) application

Claim groups (Freilich's claims as written)

1-9 RFID tag
- **Flex substrate**
- **Encoder on substrate**
- **Antenna on substrate**
- **Signal generator on substrate**

2 semiconductor formed by printing
3 polymer semiconductor
4 reactance elements by printing
5 conductor to program ID, formed on substrate
6 conductor printed on substrate
7 semiconductor printed in encoder circuit
8 polymer semiconductor
9 antenna is printed conductor

10-13 System: reader and tag, wherein tag is:
- **flexible substrate**
- **antenna**
- **circuitry**
- **pattern of conductive ink to program ID signal**

11 selectively enabled reactance elements
12 with a CHIP
13 printed semiconductor switches (change to DEVICES)

14-20 Method for producing an RFID tag
- **dispensing flexible substrate**
- **depositing ink for antenna**
- **depositing ink for signal generator**
- **cutting assembly to make ID tag**

15 semiconductor switches (change to DEVICES)
16 reactive elements
17 programming by printing
18 putting on attachment means
19 conductive: (change CONDUCTIVE to conductor, semiconductor, dielectric insulating)
20 visual pattern too

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3. Presently completed additions to Polymer Semiconductor material (5331)

Material from "Polymer Transponder with Modifiable Memory
Main document: April 7, 1997
Additional disclosure: January 19, 1998
Additional disclosure: January 20, 1998
Additional disclosure: January 28, 1998

New disclosure includes the following ideas:

Passive Read-write polymer semiconductor tag with nonvolatile memory

Read-write tag with polymer battery to back up the R/W memory

Activation of battery upon tag deployment

Nonvolatile memory with complementary polymer field effect transistors

Battery powered polymer tag with load modulation signal transmission

Battery powered polymer tag with active signal transmission

Activation of tag with conductive tape
By attaching
By removing

Printing conductive ink to activate battery powered tag
Light activation
Chemical activation
Heat activation

Power control circuitry in the tag to activate different system elements as needed

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4. Suggestions for new Polymer Semiconductor material to be developed (no #)

Polymer Transponder Patent Strategy

Consolidate all existing polymer (semiconductor) research material, ideas and presently available resources to provide patent applications with maximum coverage for polymer based RFID technologies. Provide a clear definition of "polymer" and other terms as relating to the kind of technology we intend to develop.

Presently available material and resources

Provisional patent applications (#5234)

Additional MB invention disclosures (#5331)

New web searches (July and August 1998 material)

Patent search (in process)

New Polymer Semiconductor consultant Yang Yang

Other Polymer Semiconductor consultants as needed

Strategy: Maximizing Polymer Semiconductor RFID Patent Protection

1. Write or revise claims for P5234 (Freilich) provisional app.

2. Add new material from any Beigel disclosures not mentioned in present 5234 or other patent applications.

    New provisional application?

    Continuation in part?

3. Add any enabling chemistry and fabrication information (Yang Yang, Web search)

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Chemical formulas and chemistry production process

4. Explicit materials, construction and process

for FET, diode, resistor, capacitor, inductor, conductor, insulator, etc.
Explicit materials of the FET, resistors, conductors, capacitors, inductors, batteries

5. Explicit description of the fabrication process

6. Develop model and disclosure for NONVOLATILE POLYMER SEMICONDUCTOR MEMORY ELEMENT (without battery). Use in RFID flexible wristband. Work with Yang Yang.

Any kind of polymer memory element (explicit description)

Polymer semiconductor nonvolatile memory element which does not need battery backup

7. Polymer RFID tag with fixed or programmable useful life after activation.

8. Polymer equivalent of ferrite, for concentrating magnetic field lines

9. Other new ideas and combinations which become available as a result of literature search, internal ideas or brainstorming with outside polymer semiconductor experts.

10. Acquisition of patent rights to relevant issued or patents in the field, in connection with PD polymer semiconductor experts.

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5. Patent search for issued US patents relating to polymer semiconductors

Using the IBM patent server on the Web, I searched for issued patents from 1971 to present in a number of search categories relating to polymer semiconductor technology.

The search should be expanded to include published PCT applications (or applications in countries which publish patent applications prior to issuing patents), since it is likely that a number of pending applications will not show up in a US patent search but will show up in other venues.

Issued patents were found in the following keyword categories, and the patent numbers and titles are included in Appendix 1:

The patents have not been reviewed yet.

Organic diode or polymer diode (13 patents)
Organic Semiconductor or polymer semiconductor (22 patents)
Organic semiconductor device or polymer semiconductor device (2 patents)
Organic IC or polymer IC (2 patents BUT NOT DIRECTED TO INTEGRATED CIRCUIT, they refer to isocyanates)

Most significant about the US patent search was the ABSENCE of patents for a large number of keyword categories. The following keyword searches yielded no patents:

(organic or polymer) semiconductor diode
(organic or polymer) semiconductor device
(organic or polymer) semiconductor IC
(organic or polymer) semiconductor transistor
(organic or polymer) field effect transistor
(organic or polymer) FET
(organic or polymer) integrated circuit
organic semiconductor and flexible substrate
polymer semiconductor and flexible substrate

The lack of patents with these keywords would appear to indicate opportunities for developing patents specifically emphasizing these keywords or concepts.

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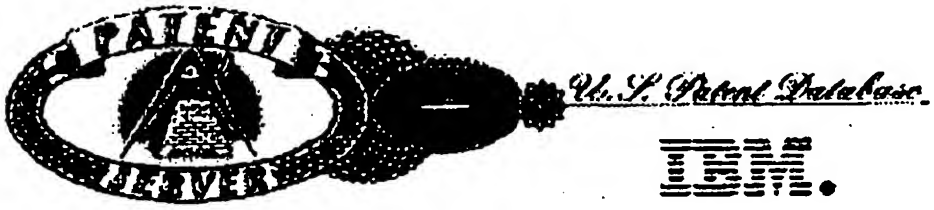
APPENDIX 1: Polymer semiconductor preliminary patent search results



Search Results

Query: (organic semiconductor) or (polymer semiconductor)

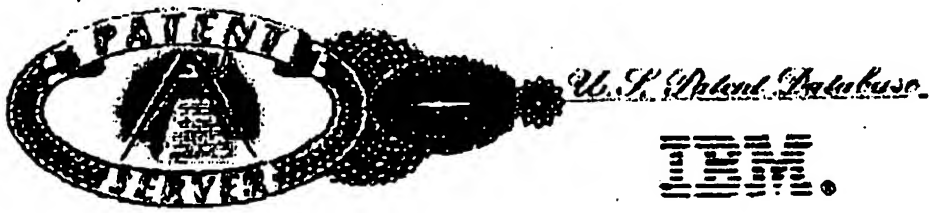
22 out of 449779 patents matched your query. The 22 most relevant ones are displayed below. Click on a patent number to view the details of a patent. Select the check boxes of patents you wish to order by fax or mail and then click on the Order button at the bottom.

→ ☐	5525811	Organic quantum semiconductor and quantum semiconductor device	100%
☐	5711897	Electrorheological fluids of polar solids and organic semiconductors	99%
☐	5682043	Electrochemical light-emitting devices	98%
☐	5623476	Recording device and reproduction device	98%
→ ☐	5574291	Article comprising a thin film transistor with low conductivity organic layer	96%
☐	5436167	Fiber optics gas sensor	92%
☐	5396483	Recording medium having a track and electrode layer provided and recording and reproducing device and system using same	92%
☐	5677572	Bilayer electrode on a n-type semiconductor	84%
☐	5607453	Composite medical treating device composed ferrodielectric substance and semiconductor	84%
→ ☐	5719033	Thin film transistor bio/chemical sensor	80%
→ ☐	5681756	Method of fabricating an integrated multicolor organic led array	80%
☐	5674636	Article comprising a microcavity light source	80%
→ ☐	5672938	Light emission device comprising light emitting organic material and electron injection enhancement structure	80%
☐	5660895	Low-temperature plasma-enhanced chemical vapor deposition of silicon oxide films and fluorinated silicon oxide films using disilane as a silicon precursor	80%
☐	5648181	Inorganic thin film electroluminescent device having a light emission layer	80%
→ ☐	5629530	Semiconductor device having an organic semiconductor material	80%
☐	5543237	Inorganic thin film electroluminescent device having an emission layer	80%
☐	5532495	Methods and apparatus for altering material using ion beams	80%
→ ☐	5500537	Field-effect transistor with at least two different semiconductive organic	80%

	5500537	channel compounds	80%
☐	5478658	Article comprising a microcavity light source	80%
→ ☐	5456862	Thermally stable forms of electrically conductive polyaniline	80%
→ ☐	5409783	Red-emitting organic electroluminescent device	80%

Order Checked Documents

Patent Number Search | Boolean Text Search | Advanced Text Search



Search Results

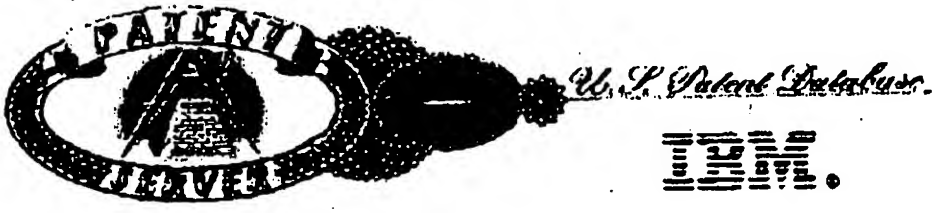
Query: (organic diode) or (polymer diode)

13 out of 2322457 patents matched your query. The 13 most relevant ones are displayed below. Click on a patent number to view the details of a patent. Select the check boxes of patents you wish to order by fax or mail and then click on the Order button at the bottom.

☐	5558904	Electroluminescent devices containing a conjugated polymer obtained via halogen precursor route chemistry	84%
☐	5504323	Dual function conducting polymer diodes	84%
☐	5733683	Electrochemical storage cell containing at least one electrode formulated from a fluorophenyl thiophene polymer	80%
☐	5723873	Bilayer composite electrodes for diodes	80%
☐	5698048	Photoresponsive materials	80%
☐	5674635	Electroluminescent device	80%
☐	5672938	Light emission device comprising light emitting organic material and electron injection enhancement structure	80%
☐	5597890	Conjugated polymer exciplexes and applications thereof	80%
☐	5563424	Polymer grid triodes	80%
☐	5560957	Electroluminescent device	80%
☐	5523555	Photodetector device having a semiconductive conjugated polymer	80%
☐	5198153	Electrically conductive polymeric	80%
☐	4936956	Microelectrochemical devices based on inorganic redox active material and method for sensing	80%

Order Checked Documents

Patent Number Search | Boolean Text Search | Advanced Text Search



Search Results

Query: (organic semiconductor device) or (polymer semiconductor device)

2 out of 2322457 patents matched your query. The 2 most relevant ones are displayed below. Click on a patent number to view the details of a patent. Select the check boxes of patents you wish to order by fax or mail and then click on the Order button at the bottom.

- [ ] 4987430 Organic semiconductor device based on phthalocyanine 87%
- [ ] 4950774 2-5,disubstituted-7,7,8,8-tetracyanoquinodimethanes 82%

Order Checked Documents

Patent Number Search | Boolean Text Search | Advanced Text Search

U.S. Patent Database

IBM.

Search Results

Query: (organic IC) or (polymer IC)

2 out of 2322457 patents matched your query. The 2 most relevant ones are displayed below. Click on a patent number to view the details of a patent. Select the check boxes of patents you wish to order by fax or mail and then click on the Order button at the bottom.

☐	4753984	Water soluble macromolecular prodrugs, their preparation and their use as antitumor and antiparasite medicines	80%
☐	3962302	Production of isocyanates from esters of carbamic acids (urethanes)	80%

Order Checked Documents

Patent Number Search | Boolean Text Search | Advanced Text Search

Home | Help | Search | Guestbook | Legal | IBM

IC does not mean what I thought it meant in these!

Don't need to review these. Ryz

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PATENT, TRADEMARK,
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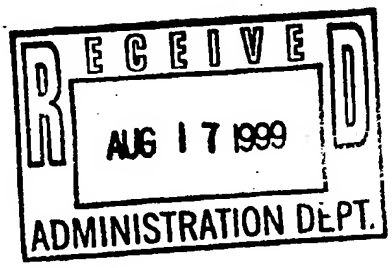
August 16, 1999



Via Overnight Courier

Attorney/Client Privileged Communication

Dr. Walter W. Mosher, Jr., President
Precision Dynamics Corporation
P. O. Box 9043
Van Nuys, California 91409

Re: RFID Program Progress Reports

Dear Walter:

Here are the first and second Program Reports. There will be one more report before Mike Beigel leaves on August 25. However, I will be in touch with Professor Yang while Beigel is away.

Best regards,

Thomas P. Mahoney

TPM:ad

cc: Mr. Oswaldo Penuela, Vice President

enc

EXHIBIT E

RFID Program Progress Report #1

August 4, 1999 Meeting

Participants: Thomas P. Mahoney, Michael L. Beigel, and Professor Yang Yang

I. - Patent Program

At the beginning of the meeting, Dr. Yang proposed three new possibly inventive concepts as follows:

1. POLARIZED POLYMER DIODE
2. PROGRAMMABLE POLYMER MEMORY
3. RADIO FREQUENCY IDENTIFICATION DEVICE INCORPORATING PROGRAMMABLE POLYMER MEMORY

Dr. Yang is in the process of preparing a definitive disclosure on the three aspects of the polarizable polymer diode as utilized for non-volatile memory in an RFID circuit.

In accordance with the instructions of Dr. Mosher, the CIRCUIT MAKING CLOSURE FOR RADIO FREQUENCY IDENTIFICATION DEVICE WRISTBAND has been docketed. Mr. Beigel is in the process of preparing a definitive disclosure on this particular invention.

It is contemplated that provisional applications may be filed on the inventions in order to obtain an early priority date.

As part of the Patent Program, it was suggested that Beigel and Yang initiate notebooks devoted to their activities on the Program.

II. - UCLA Laboratory

Through discussions with Mr. Penuela and Dr. Yang, it was established that the requisite payment had been made to UCLA and that Dr. Yang could proceed with the manufacture of conductive polymer diodes and capacitors for utilization in RFID circuits. Dr. Yang said that he would immediately approach the authorities at UCLA to inform them that he was initiating the project and to obtain the necessary paperwork such as project identification and the like. Dr. Yang said that he would begin work immediately on a first set of diodes.

III. - Reduction to Practice

Mr. Beigel indicated that, when he received the first polymer diodes produced at the UCLA Lab, he would immediately subject them to various tests establishing operating criteria necessary for RFID circuitry. He discussed with Dr. Yang the protocol which would be followed; namely, that tests would be made immediately on the first diodes so that Dr. Yang could structure the manufacture of successive products in an attempt to conform the diodes and, ultimately, polymer capacitors to the circuitry requirements of RFID's.

Thomas P. Mahoney

RFID Program Progress Report #2

August 11, 1999 Meeting

Participants: Thomas P. Mahoney, Michael L. Beigel, and Professor Yang Yang

I. - Patent Program

Dr. Yang produced a partial disclosure of the programmable polymer diode directed to utilization of the diode as a non-volatile memory in an RFID circuit. Dr. Yang and Mr. Beigel then discussed various approaches to the patent situation.

II. - UCLA Laboratory Program/Reduction to Practice

Dr. Yang produced two polymer diodes which had been manufactured in accordance with the proposal entered into by and between Precision Dynamics Corporation and UCLA. There was extensive discussion among all parties as to the manner in which the diodes should be utilized. It was decided that Mr. Beigel would test the diodes in his laboratory to determine the physical characteristics of the diodes and their applicability to RFID circuits. In addition, Mr. Beigel committed himself to the preparation of a simple RFID circuit incorporating one of the diodes.

As previously mentioned, it is contemplated that successive manufacture of diodes will be directed to improving the physical characteristics of the diodes to permit them to be incorporated in RFID circuits.

In addition, Beigel and Yang had an extended discussion of potential polymer RFID circuitry which would include, possibly, all of the necessary components of such circuitry in polymer form. Dr. Yang indicated that he would begin to evaluate the possibility of creating such circuitry. For instance, he indicated that he had already provided polymer wiring in circuitry and that, of course, he had previously created polymer diodes and capacitors. The proposed polymer diode programmable memory would be another element of the RFID circuitry.

In addition, Dr. Yang adverted to the utilization of the programmable polymer diode in photon applications where the memory embodied in a plurality of such diodes could be created in the form of a readable light context which might provide a desirable alternative to the contemplated use of the programmable polymer diode in current/voltage control.

It is also contemplated that Mr. Beigel will prepare a report for the consumption of Dr. Yang and Dr. Mosher and Mr. Penuela to indicate the feasibility of the utilization of the polymer diodes and capacitors.

III. - Phillips Polymer Activity

Dr. Yang displayed a Phillips tape illustrating Phillips' activities in the conductive polymer field. It is contemplated that the tape will be played for Dr. Mosher and Mr. Penuela at the same time that the Beigel prototype RFID circuit incorporating the initial diode manufactured at UCLA is displayed to Dr. Mosher and Mr. Penuela.

Thomas P. Mahoney

PRE-PRINT

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Dynamic Performance of Inductive RFID Systems

Michael L. BEIGEL

Abstract

This is a general introduction and tutorial regarding inductively coupled RFID systems. It summarizes the operating principles and parameters of passive-tag inductive RFID system performance, focusing on dynamic interactions between tag and reader in relative motion and the probability of successfully completed data transactions. The full-duplex (FDX) operating model is assumed in most descriptions and examples.

1 Introduction

Operation of passive tag RFID Systems: Inductively coupled RFID systems are best understood in context of the inter-relation between the systems, physics, communication, and component aspects.

An RFID READER supplies power and timing signals to the passive tag by radiating an alternating magnetic field coupled to an antenna coil into the surrounding space. An antenna coil in the ID TAG receives energy from the reader magnetic field, providing POWER and TIMING signals to the tag electronics.

The activated TAG accesses its internal DATA and sequentially varies the electrical loading of its coil according to the DATA information, modulating the amount of power drawn by the TAG from the reader field. The READER senses the variations in field power consumption corresponding to the DATA in the tag, decodes and outputs the DATA [1].

In Passive tag READ-WRITE systems, the reader can send DATA to the tag by sequentially modulating the energizing magnetic field. Additional circuitry in the tag senses and decodes the modulated reader field and puts the DATA into the tag memory or utilizes the DATA as operating commands (Figure 1).

A PROTOCOL between the reader and the tag allows for the systematic and reliable exchange of DATA in one or both directions. A DATA TRANSACTION is a completed exchange of data between reader and tag. The MESSAGE TIME is the time length for a single data transaction.

Modeling and Measuring RFID system performance: The function of the RFID system is to provide an exchange of data between readers and tags connected with a population of objects. RFID systems are highly application dependent. Performance is defined and evaluated by determining the extent to which a system meets the needs of the application. ID tags, readers and coding protocol formats vary in specific embodiments according to the requirements and constraints of the target application and environment.

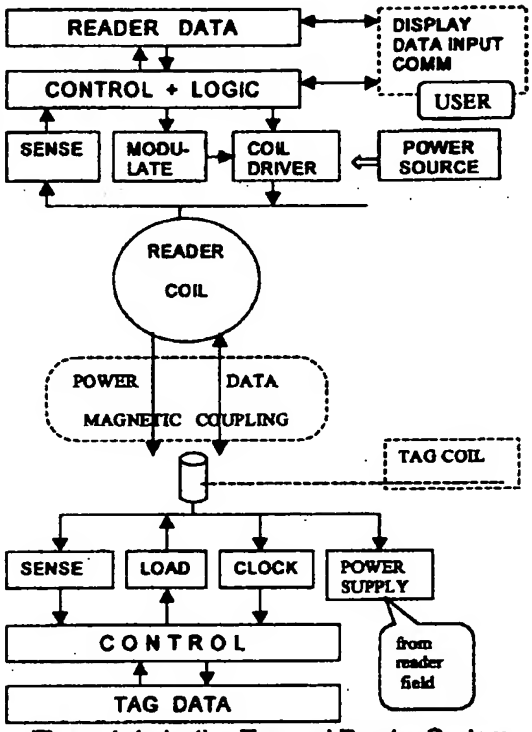


Figure 1: Inductive Tag and Reader System

Many aspects of RFID system performance can be mathematically modeled and simulated. Identifying the aspects of the system for which theoretical "ideal" performance benchmarks can be derived will enable the measurement of relative performance of a given product implementation. Comparison of the measured system performance with theoretical optimum performance allows prediction of the extent of improvement that can be achieved with subsequent product upgrades.

"Ideal" Design Objectives for RFID Systems: Some of the "ideal" performance benchmarks for RFID systems are listed below.

Beigel Technology Corp.,
308 Via Julita, Encinitas, CA 92024 USA,
URL: http://www.beitec.com,
Email: beigel@beitec.com

1. Activate the tag as far as possible from the reader coil.
2. Communicate with the tag at the tag activation distance.
3. Communicate with the tag without errors within a single message period (shortest time).
4. Activate the tag at any orientation to the reader field.

2 System Design

Size of Data Space: The required size of data space (for example, the size of a population of objects to be tagged) determines the number of unique codes needed during the useful lifetime of the ID system. Since the code space (number of unique codes possible for a system) determines both the ID tag memory size and the time length of the data transaction, the code space should be the minimum that sufficiently serves the needs of the system over the expected product life.

Reading Volume Geometry: The "reading volume" is the 3-dimensional space, referenced from the reader antenna, in which the reader can activate and communicate with a tag. Defining the required characteristics (the size, shape, orientation and intensity of field) of the reading volume dictates the specific design of the reading system. The requirements for the field geometry may differ according to whether the reader is stationary and the tags move through the reading volume, or if the reader can be moved to find a relatively stationary tag.

Tag Coil Size and Geometry: RFID tags may be designed in a variety of sizes and shapes corresponding to the needs of specific applications. For a given tag shape, a larger tag will give a greater reading distance. For maximum signal transmission the tag antenna should be as large as possible and have a shape which minimizes the directionality of response in the reading volume. Different tag coil shapes will give differing directional response to the reader field.

Tag Velocity: The highest velocity at which a tag moves through any path in the reading volume determines the minimum time length for a completed data transaction. For a successful event, the tag and reader must complete at least one sequence of a valid data transaction without transmission or reading errors during the minimum time length that the tag is activated in the reading volume.

Reliability of Data Transmission: Reliability of the data transaction, i.e. obtaining an error-free data exchange between tag and reader, can be designed into the ID system to the extent required for system performance. This is accomplished by utilizing error detecting and/or correcting code bits in the message. Increasing the number of error checking/correcting bits increases the reliability of the system performance; but also increases the tag chip size and the data transaction time. To optimize transmission efficiency versus data reliability, the reliability algorithm (checksum) should be chosen to utilize the minimum number of extra data bits adequate for the required data reliability.

Multiple Tag Protocols: Tags may have different signal transmission systems and encoding formats. In many situations, multiple tag types must be recognized and read simultaneously by a single reader system [2].

Anti-Collision: For systems in which multiple tags within the reading volume must all be recognized and read, an "anti-collision" protocol is used. The most common anti-collision protocols use methods to cause multiple tags active in the reader field to transmit their information in such a way that only one tag at a time is interacting with the reader. The transaction time for the group of tags in the reading volume must then be assumed to be at minimum the transaction time of a single tag multiplied by the number of tags in the reading volume.

Expandability of product and system designs: New types of tags will develop over the installed life of any RFID system. Reader systems must be expandable in the aspects which are easiest to change (signal and code processing), and very durable in the aspects (field activation and tag signal sensing) which must remain in place for a long time.

3 Signal Transmission Protocol

Excitation Frequency: The reader-tag system is based on a transfer of energy between L-C resonant antenna coils in the reader and the tag. Magnetic (inductive) tag-reader coupling is viable at any frequency from under 100 kHz up to approximately 50 MHz.

Regulatory Restrictions: The frequency and power of RF emissions are subject to worldwide regulation. International regulations limit commercially usable (unlicensed) radiation to specific frequency, bandwidth and field strength limits.

Reader Field Generation Pattern: The reader may emit a continuous or a pulsed field, usually at a fixed frequency. In "full-duplex" systems the reader emits a continuous RF field at a constant frequency and the tag produces a modulation signal while energized by the reader field. Continuous field emission allows tags to be activated at any time they enter the reading volume and to be decoded in the minimum possible time.

In "half duplex" systems the reader emits a pulsed field to send energy to the tag, and the tag sends back its message in the "quiet" interval between reader field bursts. This produces a quantized time window for tag and reader to interact, and could theoretically slow the minimum reading time as a result of this quantization.

For "read-write" or "query-response" systems the reader will emit either a pulsed or modulated field to

send a data signal as well as activation energy to the tag, creating quantized data transaction windows similar to half-duplex systems.

Tag Modulation method: The tag modulation method is the pattern with which the tag absorbs power from the reading system or otherwise produces a signal in order to transmit information back to the reader.

Some of the modulation patterns presently in use are:
ASK (Amplitude Shift Keying): The absorption of power from the antenna coil (loading) at a sub-modulation frequency directly constitutes logical "1", the non-absorption (unloading) of power constitutes a logical "0".
FSK (Frequency Shift Keying): The tag signal varies at two different sub-modulation frequencies, corresponding to logical "0" and logical"1".
PSK (Phase Shift Keying): The tag signal varies at a single sub-modulation frequency, but provides phase changes at specific time intervals to denote logical "0" and "1".

In FDX (full-duplex) tags which transmit the ID signal by loading the antenna coil, both FSK and PSK are variants on ASK, using the fundamental principle of sequential loading and superimposing FSK frequencies or phase shifts by varying the pattern of the loading sequence.

In certain HDX (half-duplex) tags [5] which transmit the ID signal by directly coupling an RF signal to the antenna coil from an active circuit that has been previously charged up by the reader field, the FSK or PSK signals are not superimposed patterns on an ASK signal.

Each type of modulation has advantages and disadvantages in terms of signal transmission rate, noise immunity and system complexity.

Bit Period: All "full duplex" systems currently in use derive the tag timing from the frequency of the excitation field of the reader. By counting cycles of the excitation field, the modulation periods are obtained, as well as the time length for a transmitted "bit" of information. The fewer cycles per bit (i.e. shorter time length), the faster the message transmission will be. The more cycles per bit, the more reliable the message transmission will be.

Data Structure: The Data Structure is the system of organization to transmit a coherent and reliable and information sequence between a tag and a reader. RFID tags generally transmit a message consisting of "PREAMBLE" bits to indicate the beginning of the message, "DATA" bits to transmit the ID information, and "CHECKSUM" bits to insure the reliability of the transmitted data. Similar data structures are utilized by the reader to transmit information to the tag.

Data Transaction Length: The total length (in bits and time) of the information in a particular type of data transaction. The transaction length multiplied by the TIME PER BIT equals the transaction time.

Error Checking: The CHECKSUM is calculated from the other data in the transaction. When the reader receives a tag code, it re-calculates the checksum and compares it with the data sequence. If the data transmission is correct, the calculated checksum will equal the received checksum.

4 Tag Design Considerations

Coil Size: For a given tag size, the coil size should be maximized within the tag volume to maximize the tag's ability to receive and modulate energy by means of its coded information.

Coil Resonance: Increased coil resonance also leads to higher energy transfer. A combination of a coil and a capacitor will generally form a more highly resonant circuit than a coil alone.

Operating Power Level: The power consumption level at which the IC in the tag begins reliable functioning is a prime determinant of the quality of tag performance. A tag IC that operates at a reduced power level will communicate within a weaker reader energizing field, yielding a greater potential reading distance.

Modulation Strength: The intensity with which the tag varies the loading of its antenna coil while maintaining reliable operation determines its "signal strength" to the reader. Higher signal strength contributes to greater reading distance [3, 4].

5 Reader Design Considerations

Activation Field Geometry: The first function of the reader system is to activate the tags in its reading volume. Optimally, the reader should produce an energizing magnetic field appropriate to the geometry of the reading volume and the most probable orientation of tags passing through the volume. For large reading volumes, designing a field generation system with sufficient strength, size and consistency is a primary issue in RFID research and development.

Power output: Power output of a reader's magnetic field generator may vary by orders of magnitude from the smallest hand held systems to large fixed-point installations. The requirements for constructing large and powerful magnetic field demand very efficient low-distortion electronics and resonant electro-magnetic networks.

Shielding: The power output of field generators sufficient to meet reading requirements for the largest systems may exceed regulatory agency specifications for RF emissions. In this case, electromagnetic shielding is necessary to reduce RF emissions outside the reading volume to acceptable levels.

Tag Signal Sensing: The tag signal is sensed at the reader either by sensing variations in the reader field coil signal caused by inductive coupling to the tag signal or by sensing the tag signal with a separate receiving coil(s) in the reader.

Analog Signal Processing: The analog signal processing section of the reader performs detection of a very weak perturbation signal from the tag in the presence of a strong energizing field signal. It transforms the signal by filtering and amplification to a level appropriate to digitization and further processing in the digital domain.

Digital Signal Processing: The amplified and filtered signal from the tag modulation of the reader field is digitized. Various DSP methods utilizing one-bit (comparator) and multi-bit (ADC) digitization may be more appropriate than analog processing for increasing tag signal-to-noise ratio and other signal attributes which make the tag more readable.

Decoding and Event Transmission: The digitized signal is analyzed to detect modulation patterns indicating a valid tag signal. Ideally this processing should occur simultaneously with the tag passing through the reader field. The decoded ID tag data transactions are stored, displayed, and/or transmitted to a central location for utilization.

6 Dynamic Tag-Reader Interaction

Reader Field Pattern: The electromagnetic field in the reading volume is defined by the reader coil geometry, the magnetic environment near the reader coil(s) and Maxwell's equations relating to magnetostatics. The field will generally not be consistent in intensity or orientation, due to all these factors.

Static Tag Position and Orientation: For a tag stationary in the reader field at a given position and orientation, a deterministic function of tag activation is associated with the variation of magnetic field strength and orientation of the reader field. The maximum reading distance for a stationary tag in the reader field is a function of the field strength and the tag orientation in the field. This function, though complex, may be integrated over all possible static tag orientations within the reading volume to yield a probability of reading the static tag in the volume for all possible tag orientations.

A tag will have the greatest activation distance at optimum orientation to the reader field lines, and less (or no) activation distance as a function of sub-optimal orientation. The threshold of tag activation therefore varies as a direct function of the field strength and as an inverse function of the distance between the tag and the reader. The probability of reading a stationary tag in the reading volume can be computed as a function of the activation distance for all tag orientations and the probability of tag orientation in the given direction throughout the volume (Figure 2).

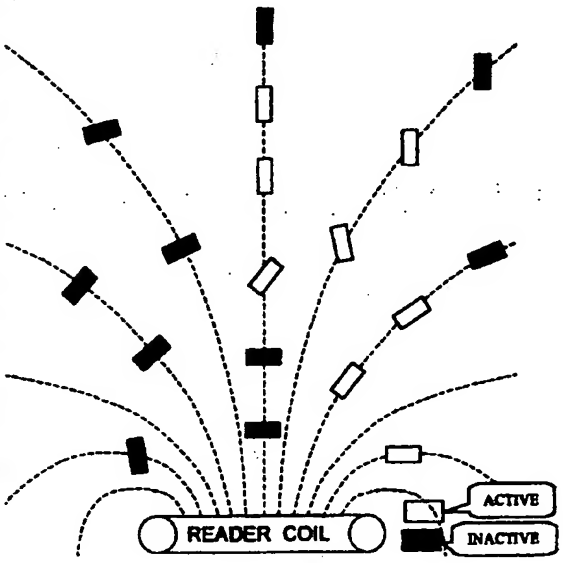


Figure 2: Tag Orientation in Reader Field

Tag Speed and Trajectory: The amount of time the tag is activated by the reader field also affects probability of reading. The theoretical best case is that the reader can read the tag if it is active for one message period. A tag can move through the reading volume at a variety of speeds and trajectories (speed, position, orientation). For a given trajectory through reading volume, there is a maximum speed at which a tag can move through the volume and remain active for a sufficient length of time for a complete data transaction.

An "ideal" reader could receive and decode the message in the time period corresponding to the maximum speed per trajectory. Above this speed, the probability for obtaining a reading is zero. A tag can also move through the reading volume with varying orientation, thereby varying its relative signal strength or even going through periods of de-activation on its way.

For all speeds below the maximum speed, the probability of data transaction increases dependent on tag speed, orientation, trajectory, reader signal-to-noise ratio and other factors. The probability that a tag will be readable on account of its trajectory could be computed taking all these factors and all possible trajectories into account (Figure 3).

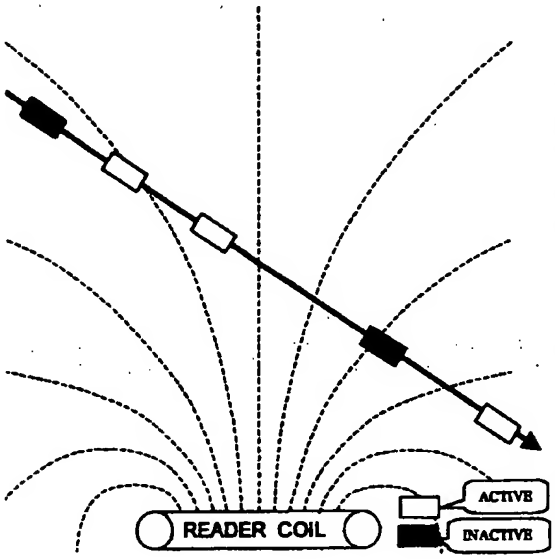


Figure 3: Tag Trajectory in reader field

Multiple Tags: If more than one tag is activated within the reading volume at a given time, the tag signals will interfere, giving an ambiguous message to the reader. Depending on the modulation method used in the tags, this mutual interference has a variable effect on whether a valid reading of any tag in the field will take place.

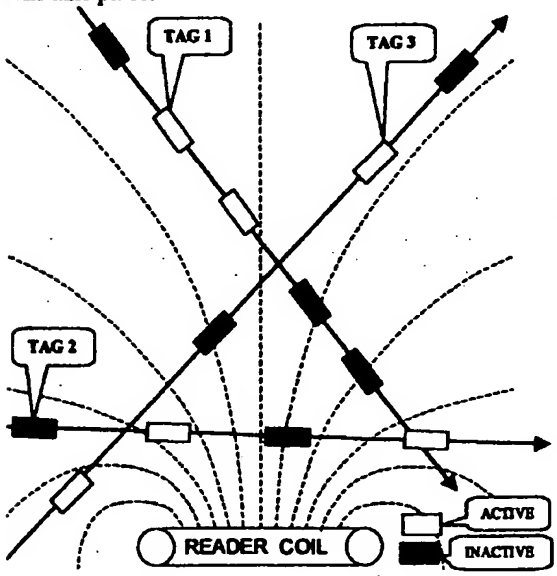


Figure 4: Multiple tag Trajectories in Reader Field

Even in systems that utilize "anti-collision" methods, multiple tags in the field will increase the amount of time necessary for completed data transactions with all the tags. Therefore another probability function for multiple tags in the reading volume simultaneously may be computed by: the trajectory of each tag, the number of tags in the volume, and the nature of the anti-collision algorithm (Figure 4).

Noise Sources: Electromagnetic noise sources in the vicinity of the reader will decrease the probability of a successful data transaction. If the tag outputs a good signal in the presence of noise, the probability of the reader receiving erroneous information along with the tag signal increases according to a function of the noise intensity and frequency spectrum as related to the signal processing characteristics of the reader.

7 Conclusions

Understanding the diverse and interactive aspects of RFID technology, particularly in dynamic systems (tag and reader in relative motion), will enhance the possibility of optimizing system and product designs for specific applications.

Systems and products may be optimized for such qualities as: maximum reading distance, maximum reading volume, minimum system power output, non-directional tag reading characteristics, minimum tag size, minimum data transaction time, most reliable (or secure) data transaction, maximum number of tags simultaneously in reader field, and others.

Compliance with *de facto* and legal transmission and protocol standards limits design flexibility but provides the opportunities for interoperability of systems and wider markets.

Optimizing systems and products for multiple objectives requires careful judgement regarding the design trade-offs, and the continuous challenge of improving the "state of the art" in RFID.

References

[1] US Patent 4,333,072 "Identification Device" Michael Beigel, June 1, 1982

[2] Objective Measurements for RFID System Performance, Michael Beigel, January 1993 http://www.rapidttp.com/transponder/beigel.html

[3] RFID Design Guide, Microchip Technology, 1997

[4] Remote Control and Identification Systems Design Guide, TEMIC Semiconductors, August 1997

[5] Schuermann, J., Meier, H., TIRIS - Leader in radio frequency identification technology, Texas Instruments Technical Journal, TITJ Vol.10, No. 6, Nov. 1993, pp. 2-14

RFID Program Progress Report #7

October 6, 1999 Meeting

Participants: Thomas P. Mahoney, Michael L. Beigel, and Professor Yang Yang

I. - Prototype Testing

Mr. Beigel disclosed that he had re-tested the No. 2 prototype in accordance with an alternative test protocol. It was noted that the frequency response was greatly improved and a considerable improvement in the power supply aspect of the No. 2 prototype was detected. Mr. Beigel disclosed the graphs and printouts from the oscilloscope indicating the test results.

It is contemplated that there will be a re-test of prototypes Nos. 2 and 3.

II. - Professor Yang Report

Professor Yang presented a report on the analysis of the No. 3 prototype and a discussion was had regarding the same. A copy of Professor Yang's notes dated 10/6/99 is appended hereto.

III. - Prior Art Discussion

Mr. Beigel brought to our attention U.S. Letters Patent No. 5,006,830 as possibly of interest to Precision. It relates to a method and device for deterring the unauthorized removal of a newborn from a defined area. A copy of the Abstract of the '830 patent is appended to this report. There are evidently 15 claims in the patent which includes a locking umbilical clamp with an attached identification mark and an attached triggering device for triggering a detection system on the removal of the umbilical clamp from the defined area and a wristband with an identification mark corresponding to the identification mark on the clamp for attachment to the wrist of a person authorized to remove the newborn from a defined area.

A method claim goes through the steps of providing an umbilical clamp containing a triggering element with a distinctive identification mark thereon and clamping the umbilical cord of the newborn with a clamp. The additional steps include providing a detection system capable of determining when the triggering element comes within a pre-defined proximity of an exit from a defined area and providing an alarm system that is activated when the detection system determines that the triggering element is in proximity of an exit and placing the newborn with the triggering element attached within the defined area.

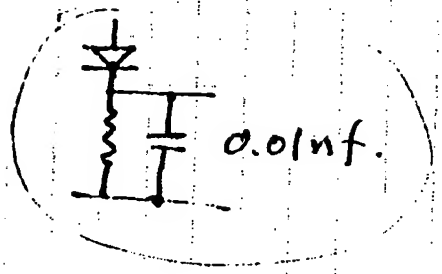
Thomas P. Mahoney

EXHIBIT F

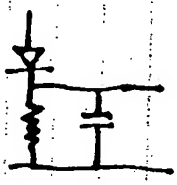
10/6/99

9:30Am -

- Polymer diodes fast;
- tunneling diode;
- ~~Contract~~
- research grant → proposal ?



- a single diode  responds up ~~to~~ 100 Hz.
- but the circuit responds up to 1 MHz.



- this might be an approach to fast switch devices, without the re-invents of new materials.

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re-test #2 & #3 batch devices by Michael Biegle.

Memory:
Opticom disclosure is not a valid disclosure to prevent us to file PPD patent.